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Assessment of Tutors' Level of ICT Competencies in Teaching in Teacher Education in Tanzania

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Abstract: This study assessed tutors' level of ICT competencies and factors that influenced application of ICT-pedagogical competencies in teaching in two Teachers' Colleges. It adopted the level of ICT competencies from the UNESCO ICT-Competence Framework for Teachers. A self-rating questionnaire was used to collect numeric data involving 70 tutors. Two Focus group Interviews involving eight (8) participants in each college among the 70 respondents were used to collect qualitative data. Mean scores and independent sample t-test were used to compare respondents' level of ICT competencies. Standard multiple regression was used to evaluate the contribution of factors in predicting ICT-pedagogical competencies. The findings revealed that knowledge acquisition was high, which signifies confidence in basic ICT skills. Knowledge deepening was low, which signifies low application of ICT-pedagogical competencies in teaching across subjects. Regression results revealed that practice had a positive unique influence in predicting tutors' competencies in knowledge deepening. These findings suggest that tutors need more hands-on training in applying ICT-pedagogical competencies in their classroom practice.

Keywords: ICT competencies, knowledge acquisition, knowledge deepening.

Introduction

Worldwide, ICT competencies are considered an essential requirement for teaching and learning in teacher education institutions (Ferrari et al., 2014; Tondeur, 2018; UNESCO, 2017). Teacher educators are expected to demonstrate best practice in the use of ICT in teaching in order to develop teachers who can apply technologies in their teaching at schools. There is consensus across studies that, competencies expected for effective ICT use in teaching and learning form a composite of knowledge domains for subject content, pedagogy and ICTs (Koehler et al., 2013; Tondeur, 2018). However, ICT frameworks adopted different foci to develop these competencies. The most common foci are in teaching subjects and ICT in education competencies (UNESCO, 2018)

Studies confirm that, the Technological Pedagogical Content Knowledge (TPACK) focuses on teaching subjects (Tondeur, 2018; UNESCO, 2018). In this framework, subject content and pedagogical content knowledge (CK and PCK) determine appropriate technological knowledge (TK) required to address the learning needs of the subject matter (Mishra & Koehler, 2006; UNESCO, 2018). Whereas, the UNESCO ICT competence framework for teachers (ICT_CFT)(UNESCO, 2018) focuses on ICT in education competencies. Like TPACK, the UNESCO ICT-CFT consider quality learning as an essential outcome of effective use of ICT competencies in education. While TPACK focuses on integration of knowledge domains in a lesson or topic, the UNESCO ICT-CFT focuses on the ends for technology

use and the function of specific ICT resources in addressing the learning needs of the subject matter (Kozma, 2011; Krumsvik, 2014; UNESCO, 2018).

This paper was concerned with application of ICT competencies in teaching in teachers' colleges. The study was triggered by the persistence of tutors' limited ICT use in teaching as found in the evaluation report for the ICT project for teachers colleges (Bernt et al., 2014). Similar results were noted in two successive ICT competencies development initiatives, namely Teacher Development and Management strategy TDMS (MoEVT, 2015; URT, 2017), and the baseline survey for Teacher education support project TESP (Binde et al., 2017). It was not clear whether the problem was with the competence development process or the application of developed competencies in teaching and learning in teachers' colleges. Consequently, this paper intended to clarify the reasons for this competence development and practice gap by reporting findings from a study that assessed tutors' level of ICT competencies, and evaluating factors that influenced application of these competencies in teaching across subjects learnt in Teachers' Colleges.

Development of Tutors' ICT in Education Competencies

In Tanzania, tutors' ICT competence development is informed by the Education and Training Policy ETP (URT, 2014) and the National ICT Policy NICTP (URT, 2016). These policies consider the use of ICT in education as a useful supplement to the development of competent and competitive human capital in line with the knowledge economy's needs. Development of tutors' ICT in education competencies was considered a strategic entry point under the human capital competence development value chain. ICT in education competent tutors were expected to prepare student teachers who can use ICT in teaching at schools after graduation from Teachers' colleges(Bernt et al., 2014). However, effective preparation of teachers depended on tutors' competencies and disposition in the use of ICT as a pedagogical tool in teaching and learning (Ndibalema, 2014; Tondeur, 2018).

Systematic development of tutors' ICT competencies occurred in several initiatives. However, this paper focused on three large scale initiatives which focused on all current 35 public teachers' colleges and all tutors. The first was the ICT project for Teachers' Colleges 2005-2008 initiated by the Government of Tanzania under the Swedish International Development Agency's (SIDA) financial support (Bernt et al., 2014). The second was the Teacher Development and Management Strategy (TDMS) 2008-2013 (URT, 2017), under the then Ministry of Education and Vocational Training (MoEVT). The third was the Teacher Education Support Project (TESP) (2017-2021) (Binde et al., 2017), initiated by the Ministry of Education Science and Technology (MoEST) under the financial support of Global Affairs Canada.

Despite taking place in different years, the initiatives shared a number things. First, both developed tutors' basic ICT skills and ICT in education competencies. It seemed that, in each initiative, there were tutors whose ICT skills were at basic level and some had ICT in education competencies as classified by UNESCO ICT-CFT (UNESCO, 2018). Second, both focused on development of tutors' ICT competencies as a basis for preparation of teachers who can use ICT in teaching at schools. Third, both initiatives used similar yet separate content for basic ICT skills and ICT competencies for teaching and learning (Bernt et al., 2014; Binde et al., 2017).

Tutors' basic ICT skills entailed the use of word processing, spreadsheets, presentations, databases, and internet browsing as well as communication through e-mail, and social media. This content was

consistent with the International Computer Driving License (ICDL) used as an assessment standard (Bernt et al., 2014), whereas the ICT in education competencies consisted of mapping web resources with subject content, multimedia lesson presentations, using the Moodle learning management system (LMS), and e-learning knowledge and skills (Bernt et al., 2014). In an ideal situation, basic ICT skills and ICT in education competencies were expected to be a continuum in ICT competence development (UNESCO, 2018). However, their separation yielded basic ICT skills with technological competencies as an end and ICT in education competencies.

Kozma, (2011, 4), classifies ICT competencies into emerging, applying, infusing and transforming stages. However, he considers "emerging" and "applying" as basic ICT skills because they focus on technology proficiency as an end. However, during the ICT project for TCs, tutors' training on basic ICT skills was determined by their level of ICT proficiency in accessing teaching and learning resources and participating in professional learning (Bernt et al., 2014). It was highly probable that the intention to develop basic ICT skills was to prepare tutors for more complex application of ICTs in teaching and learning.

The infusing and transforming stages are the potential competencies for ICT in education to contribute in addressing the learning needs of the subject matter (Kozma, 2011; UNESCO, 2015). However, their contribution is never automatic, rather they need a seamless blending with appropriate subject content and pedagogical content knowledge to address the learning needs in a lesson or topic. Transforming is the highest stage, where ICT competencies contribute in creating new usable knowledge with benefits to the practitioner as an individual and towards societal good (UNESCO, 2018). Like Kozma's stages, Krumsvik, (2014), uses adoption and adaptation for basic ICT skills, and appropriation and innovation for application of ICT competencies in a lesson or topic.

Unlike stages of technology proficiency, the UNESCO ICT-CFT uses levels of ICT competencies to classify ICT use by combining knowledge about technologies with domains of practice which link the knowledge with practice (UNESCO, 2018). Table 1, summarises the UNESCO levels of ICT competencies and domains of professional practice expected of teaching staff.

Table 1: The UNESCO Levels of ICT Competencies and Domains of Professional Practice. Source: ICT-Competence Framework for Teachers (UNESCO, 2018)

Approach **Domains**	**Knowledge Acquisition**	**Knowledge Deepening**	**Knowledge Creation**
Understanding ICT in education policy	Policy understanding	Policy application	Policy innovation
Curriculum and assessment	Basic Knowledge	Knowledge Application	Knowledge society skills
Pedagogy	ICT- enhanced teaching	Complex problem solving	Self-management
Application of digital skills	Application	Infusion	Transformation
Organization and administration	Standard classroom	Collaborative groups	Learning organizations
Teacher professional learning	Digital Literacy	Networking	Teacher as innovator

Tanzania adopted knowledge Acquisition and Knowledge Deepening levels into her ICT competence standards for teachers (ICT-CST) (URT, 2015), from the UNESCO ICT-CFT (UNESCO, 2018). Knowledge Acquisition is considered the basic level of ICT competencies which manifest in the ability to use technologies as a supplement to classroom practice while enhancing users' technological competencies (UNESCO, 2018). Although the classification considers technology proficiency as an end, which is similar to Kozma's emerging and applying stages, the ICT-CFT framework supports a move from a focus on technology as an end to application of technology in teaching and learning (UNESCO, 2018).

Knowledge deepening strives for collaborative solution co-creation to a learning need or problem in a subject area (UNESCO, 2018). To be competent in this level, requires tutors' ability to identify the teaching and learning needs that demand for ICT intervention, then selection and effective use of appropriate technologies to meet the intended learning needs (UNESCO, 2018). Knowledge Creation level strives for lifelong higher-order capability in generating new usable knowledge for addressing real life problems within or beyond teaching and learning, for personal as well as societal good (UNESCO, 2018).

Further, Tanzania adopted the six domains of professional practice (Table 1) from the UNESCO ICT-CFT. The first domain, understanding ICT in education strives for informed interpretation of policy rationale for ICT competences in education and to develop capability to discern when, where, how and why ICT should be integrated in teaching (UNESCO, 2018). Second, curriculum and assessment calls for tutors' mastery of subject content and assessment criteria supporting teaching and learning. Third, pedagogy calls for tutors' ability to identify and apply the diverse strategies needed to orchestrate the learning process in relation to the subject, level of learners, and learner centered learning needs (UNESCO, 2015, 2018).

Fourth, application of digital skills encourages active participation in learning communities as the niche for knowledge co-creation and sharing appropriate technologies to particular learning needs (UNESCO, 2018). Fifth, organisation and administration requires the demonstration of capability to create the physical learning environment that supports application of ICTs in teaching (UNESCO, 2018). Expectations in this organisation include; preparation of ICT facilities and how they can be used to support collaborative learning and bridging classroom and virtual learning environments (van Wyk, 2018; Young, 2017).

Sixth, professional learning strives for sustainable learning and practice. At a basic level, emphasis is on the ability to use evolving digital technologies to support one's own professional learning (Ferrari, 2012; From, 2017). Whereas, knowledge deepening requires demonstration of the ability to participate actively in learning networks for knowledge co-creation and sharing innovative teaching strategies (UNESCO, 2015, 2018). However, to avoid mixing the ICT competencies applied by tutors, this paper uses basic ICT skills for technology proficiency and ICT-pedagogical competencies for ICT in education competencies based on UNESCO ICT-CFT (UNESCO, 2018).

The Study Gap

Bernt et al. (2014) reveal that, between 2005 and 2008, the ICT project trained 549 tutors in basic ICT skills using the ICDL standard, and by 2011, 457 tutors were trained in the application of ICT-pedagogical competencies in teaching. However, the project evaluation conducted in 2014 revealed

that, out of 457 tutors trained for ICT in teaching, only 44% of the 80% evaluated used ICT in teaching and learning. However, the nature of ICT use by the majority (62%) was searching for teaching and learning materials for their subjects (Bernt et al., 2014, 25). Studies consider searching for materials in the internet as a basic ICT skill (Ferrari, 2012; Fraillon et al., 2019).

Similarly, the TDMS evaluation report concluded that, tutors' ICT skills were basic and needs sustainable measures (MoEVT, 2015). Further, the TESP baseline survey conducted in 2017 revealed that, tutors' ICT use was mainly in basic knowledge and skills (Binde et al., 2017). Supporting this claim, the TESP annual implementation report (unpublished) of September 2019 revealed that 728 tutors from all 35 Teachers' Colleges were trained for ICT competencies. However, 457 had to start with basic ICT skills (Level 1), and 271 started with ICT-pedagogical competences (Level 2). Although the modality for placing tutors in either of the proficiency levels was not revealed, having the majority of tutors in basic ICT skills and in different projects suggests that, ICT-pedagogical competencies were not adequately applied in teaching and learning.

These reports not only suggested inadequate use of ICT in teaching and learning but also raised a question about whether tutors were capable to apply their ICT-pedagogical competencies in teaching. This paper, therefore, reports findings from a study which assessed tutors' level of ICT competencies, and factors that influenced their application of ICT-pedagogical competencies in teaching.

Methods

Study Location

The study was conducted in two public TCs in Tanzania named by the pseudonyms "*Mkasiwa*" and "*Mianzini*", located in the Dodoma and Iringa regions, respectively, from February 19 to March 17, 2020. This was during the pre-test phase of the ongoing intervention study for strengthening tutors' ICT-pedagogical competences which involved the authors with tutors. The choice of study location was purposively made because the colleges acted as hubs for tutor professional learning for ICT-pedagogical competencies from the inception the ICT project in 2005 to the TESP (Binde et al., 2017). Thus, they had functional ICT facilities for teaching and tutors who participated in ICT competence development from 2005 to 2019, which made them data rich for the study.

Data Collection and Analysis Methods

The study adopted a mixed methods approach to obtain data for enriched understanding of the study problem (Creswell & Plano Clark, 2018). Data were collected from both Mkasiwa and Mianzini's TCs using a semi-structured questionnaire, which yielded a response rate of 70. Data from the questionnaire focused on tutors' practice in knowledge acquisition and Knowledge Deepening levels of ICT competencies (UNESCO, 2018). Convenience non-probability sampling technique was used to select respondents for the pre-test survey. This sampling technique was adopted to collect data used in this paper from an accessible population during the pre-test survey as recommended by West, (2016).

Qualitative data were collected using focus group interview (FGI) which involved eight (8) participants from Mkasiwa and eight (8) from Mianzini's TC. The use of FGI helped the researchers to confirm not only tutors' application of ICT-pedagogical competences, but also to understand factors that influenced the tutors' competencies in teaching. The use of FGI involved asking a question that

required multiple participants to answer up to the saturation point as indicated by Cohen et al., (2018). Purposive sampling was used to select tutors among the pre-test survey respondents from different specialisation subjects as participants for FGI. Our interest was to understand different ways in which participants experienced application of ICT competencies in teaching their specialisation subjects in order to avoid a biased interpretation of findings as recommended by Cohen et al., (2018).

FGI questions on ICT use and factors influenced application of ICT-pedagogical competencies that were informed by ICT competence frameworks' literature (Ferrari et al., 2014; Koehler et al., 2013; UNESCO, 2018). The factors were also informed by ICT competence studies with validated questionnaires (Fraillon et al., 2019; Tondeur et al., 2017). Moreover, documentary analysis was used to collect information from documents, like lesson plans and government reports needed in the study. The choice of a mixed methods approach, data collection methods and tools were informed by the need to confirm data for informed interpretation of findings.

Data from the questionnaire were analysed using IBM Statistical Package for Social Sciences (SPSS) Version 22. Descriptive statistics were used to compare mean scores for technologies used by tutors in Knowledge Acquisition (TUKA) and Knowledge Deepening (TUKD) levels of ICT competencies.

Independent Sample t-test was used to determine the level of significance and effect size of respondents' mean scores for two groups of TUKA (G1and G2). The use of word processing, spreadsheets and presentations formed G1, and the use of web browsers like Google Search, communication through e-mail and social media in teaching and learning formed G2. A similar test was conducted to mean scores of three TUKD groups (G1, G2 and G3). The first group G1, assessed tutors' use of ICT in teaching, learning and assessment for learning. The second (G2) focused on tutors' use of apps for creating graphics, audio, video and multimedia learning resource, and the third, (G3) focused on tutors' use of ICTs resources for content creation, sharing and supporting learners' needs during the lesson.

Furthermore, the standard multiple regression test was used to assess the contribution of the factors that influenced tutors' use of ICT competencies (independent variables) in explaining tutors' TUKD practice (dependent variable) as informed by Pallant (2020).

Data from FGI and documentary reviews were transcribed and sorted and relevant participants' expressions (excerpts) and information from documents were identified and used as evidence to support interpretation of findings as recommended by Cohen et al., (2018).

Results

Tutors' Level of ICT Competencies by Sex

Knowledge acquisition was the most prominent level of ICT competencies afforded by tutors. This was revealed by both male and female tutors' highest mean scores ($\bar{x} \geq 4$) in TUKA_G1 and TUKA_G2 for word processing, and information access and communication through the internet and e-mail, respectively. Use of spreadsheets was moderate ($\bar{x} = 3.5$). However, male respondents rated slightly higher than their female counterparts in the use of spreadsheets, presentations and use of social software in teaching and learning. Table 2 summarises TUKA results using the scale: 1 = not confident at all, 2 = slightly confident, 3 = somewhat confident, 4 = quite confident and 5 = highly confident.

Overall, TUKA results (Table 2) suggest that, respondents were competent in basic ICT skills with the highest mean scores ($\bar{x} \geq 4$), and moderate levels ($\bar{x} \geq 3.5$ and ≤ 3.9) in some applications as illustrated in Table 2. Moderate scores ranging $\bar{x} \geq 3.5$ and above suggest some progress towards confident use of basic ICT skills in carrying out general activities. This finding suggests that the competence development initiatives engaged tutors in practical use of ICT tools and software in their daily activities. Unlike TUKA, respondents' level of ICT in Knowledge Deepening was low. Findings from TUKD (G1, G2 and G3) reveal the highest mean score of ($\bar{x} \geq 3.3$) in the use of Learning Management Systems, and the lowest ($\bar{x} \leq 2.5$) in the use of audio tools to support learners with visual impairment.

Table 2: Tutors' level of ICT competences in Knowledge acquisition. Source: field data.

		Male		Female	
Variables	**Description**	**Mean**	**SD**	**Mean**	**SD**
TUKA1_G1	Create a document with texts, tables, graphics and hyperlinks using **word processing** program	4	0.9	4.1	0.8
TUKA2_G1	Present charts, grades, rank items and descriptive statistics using spreadsheet application	3.7	1	3.5	0.9
TUKA3_G1	Create basic **presentation** for a lesson in your subject topic using PowerPoint or similar program	4.2	0.9	3.9	1
TUKA4_G2	Search electronic content from the **internet** and save in your computer hard drive.	4.2	1	4	0.8
TUKA5_G2	Send **e-mail** with an attachment	4.3	0.9	4.3	0.8
TUKA6_G2	Use **social media** like Facebook, twitter and WhatsApp to engage student teachers in academic interaction and active learning	3.8	1	3.6	1.3
Valid N (list)	70				

Table 3 summarises findings from TUKD using the scale: 1 = not confident at all, 2 = slightly confident, 3 = somewhat confident, 4 = quite confident and 5 = highly confident.

Overall TUKD results (Table 3) show that, respondents were somewhat confident in TUKD with mean scores ($\bar{x} \geq 3$ and ≤ 3.3). The findings reveal uncertainty of whether respondents were or were not able to apply their ICT-pedagogical competences in teaching. This is because the mean scores for all TUKD variables were less than ($\bar{x} < 3.5$) which suggests that they were struggling to model effective ICT-pedagogical competences. Nevertheless, male respondents rated slightly higher than their female counterparts in all TUKD variables, as illustrated in Table 3. This difference could have been caused by limited application of ICT-pedagogical competencies among female respondents who were few in number, 15 (21.4%) compared to 55 (78.6%) male respondents.

Table 3: Tutors' level of ICT competencies in knowledge deepening by sex. Source: field data.

Variables	Description	Male Mean	SD	Female Mean	SD
TUKD1_G1	Create learning activities and assessment tools for student teachers using learning management platforms (e.g., Moodle, Blackboard)	3.3	1	3.2	1.2
TUKD2_G1	Use educational computer games to enhance student teachers' creativity in teaching and learning.	3	1	2.7	1
TUKD3_G1	Using subject specific apps (e.g., puzzles) in teaching and learning	2.8	1	2.3	0.8
TUKD4_G1	Use free online library to access and share digital content for learning	3.2	1	3	1.1
TUKD5_G1	Use online support forum to ask for and share teaching and learning resources.	3.1	1	2.9	0.9
TUKD6_G1	Use electronic portfolio to assess student teachers' learning progress.	2.9	1	2.8	0.8
TUKD7_G1	Assess your student teachers using online tests and examinations.	2.7	1	2.8	1
TUKD8_G2	Create audio clips for learning using audio editing software like Audacity	3	1	2.2	1
TUKD9_G2	Create graphics for learning using graphics editing software and tools (e.g., Photoshop, Paint, Snipping tool).	2.9	1	2.2	1
TUKD10_G2	Create video clips for teaching and learning using video editing software (e.g., Movie Maker).	2.9	1	2.1	1.1
TUKD11_G2	Create interactive content for teaching and learning using free multimedia-based learning software (e.g., simulations, animations)	2.9	1	2	1
TUKD12_G3	Use audio voice tools (e.g., Narrator, Jaws, and Dolphin pen) to support student teachers with visual impairment.	2.5	1	1.6	0.7
TUKD13_G3	Use online educational video access and sharing sites (e.g., YouTube)	3.3	1	2.5	1.1
TUKD14_G3	Share electronic content using file sharing applications (e.g., Dropbox, Google Drive)	2.9	1	2.6	1.2
Valid N (list)	70				

Tutors' Level of ICT Competencies by Duty Station

Similarly, respondents' mean scores in TUKA by duty station revealed a high level ($\bar{x} \geq 4$) in some variables and moderate levels in others ($\bar{x} \geq 3.5$ to 3.9), as illustrated in Figure 1.

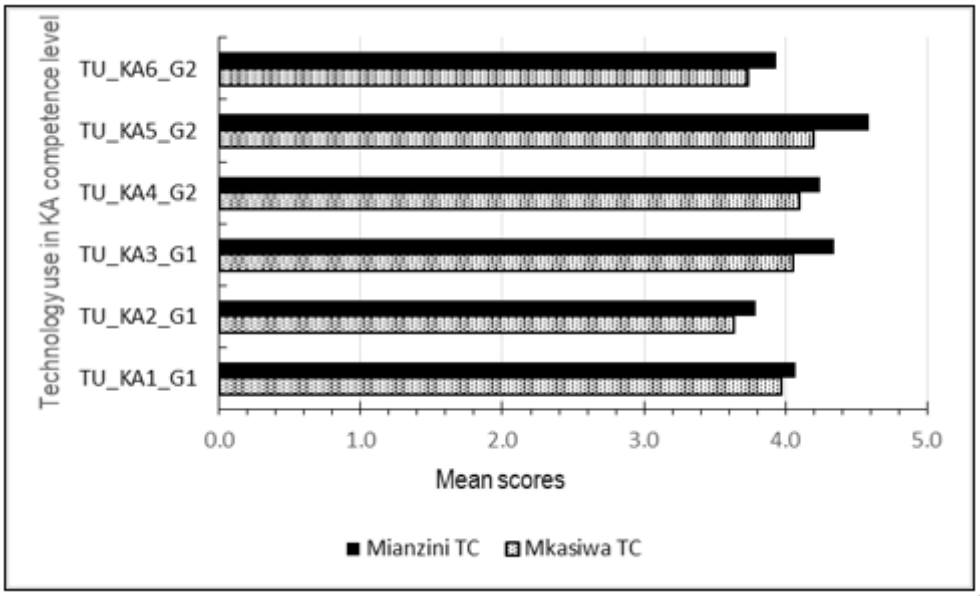

Figure 1: Tutors' level of ICT competences in Knowledge Acquisition by duty station

As illustrated in Fig.1, respondents rated a high proficiency ($\bar{x} \geq 4$) in several TUKA applications. These applications include communication through e-mail (TUKA5_G2), presentation applications like PowerPoint (TUKA3_G1), internet browsing to access and share teaching and learning resources (TUKA4_G2) as well as word processing (TUKA1_G1). Overall Knowledge Acquisition results show that, tutors at Mianzini TC had slightly higher proficiency in basic ICT skills than their Mkasiwa TC counterparts. However, in terms of application, tutors in both colleges seemed to be confident in their basic ICT skills, with the highest mean score ($\bar{x} \geq 4$) in some TUKA applications. Similarly, the moderate level ($\bar{x} \geq 3.5$ to 3.9) revealed progress towards confident application of TUKA variables. However, confidence in TUKA is an indicator of knowledge about respective technologies and their uses.

Knowledge deepening competence level was generally low, as a large number of applications had a mean score below 3.5 in both Mkasiwa and Mianzini TC as illustrated in Figure 2.

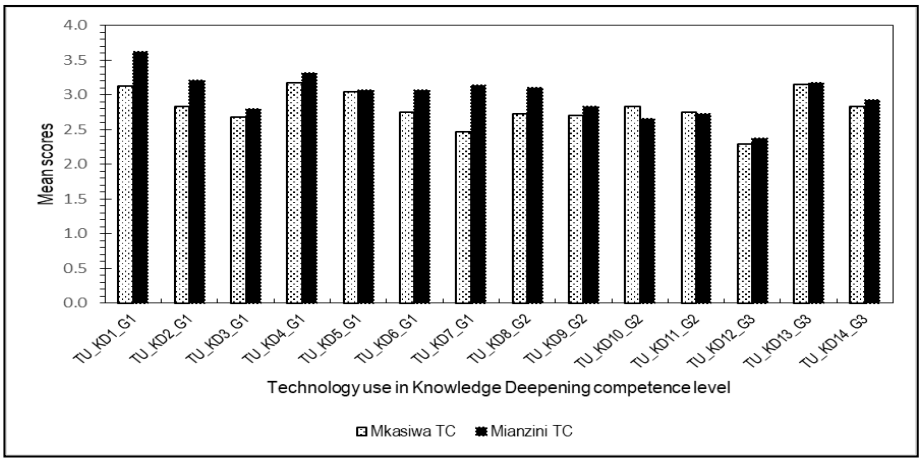

Figure 2: Tutors' level of ICT competencies in Knowledge deepening

Overall, knowledge deepening was low ($\bar{x} < 3.5$) in most variables. The highest mean score was ($\bar{x} \leq 3.7$) was lower compared to knowledge acquisition ($\bar{x} \geq 4$). The results suggest that tutors' practice was more evident in basic ICT skills than in ICT-pedagogical competences. Moreover, having a moderate ($\bar{x} \leq 3.7$) level of knowledge deepening, suggests that, some tutors had experience in ICT-pedagogical competence, though not necessarily applied in teaching. The findings reveal a gap between understanding about ICTs and application of the same in teaching and learning.

Comparing the Level of ICT Competencies

The study used independent sample t-test to discern whether there was any statistically significant difference in respondents' mean scores for the TUKD dependent variable by sex and duty station independent variables. TUKD was focused because it was the potential level for ICT contribution addressing the learning needs in a lesson. The results are summarised in Tables 4.1 and 4.2 for TUKD by sex and duty station, respectively.

Table 4.1: Group statistics on overall mean scores for Knowledge deepening by sex. Source: field data.

Competence Levels	Sex	N	Mean	SD	t-value	p-value
TUKA_G1_Pre	Male	55	12.0	2.55	0.492	0.624
	Female	15	11.6	2.47		
TUKA_G2_Pre	Male	55	12.5	2.50	0.831	0.409
	Female	15	11.9	2.13		
TUKD_G1_pre	Male	55	21.3	6.84	0.813	0.419
	Female	15	19.7	5.43		
TUKD_G2_Pre	Male	55	11.8	4.55	2.462	0.016*
	Female	15	8.7	3.72		
TUKD_G3_pre	Male	55	8.8	3.46	2.066	0.043*
	Female	15	6.8	2.57		
Overall TUKD pre	Male	55	41.9	13.76	1.766	0.082
	Female	15	35.2	9.54		

Note: SD = standard deviation, * = the compared groups were statistically significantly different.

Similarly, Table 4.2 compares group statistics on overall mean scores for knowledge deepening TUKD by duty station.

Table 4.2: Group statistics on overall mean scores in Knowledge deepening by duty station. Source: field data.

Competence Level	Duty Station	N	Mean	SD	t-value	p-value
TUKA_G1_Pre	Mkasiwa TC	41	11.7	2.68		
	Mianzini TC	29	12.2	2.29	-0.895	0.374
TUKA_G2_Pre	Mkasiwa TC	41	12.0	2.68		
	Mianzini TC	29	12.8	1.98	-1.254	0.214
TUKD_G1_pre	Mkasiwa TC	41	20.1	7.20		
	Mianzini TC	29	22.2	5.41	-1.415	0.162
TUKD_G2_Pre	Mkasiwa TC	41	11.0	4.60		
	Mianzini TC	29	11.3	4.57	-0.257	0.798

TUKD_G3_pre	Mkasiwa TC	41	8.3	3.41		
	Mianzini TC	29	8.5	3.37	-0.26	0.795
Overall TUKD_pre	Mkasiwa TC	41	39.4	13.86		
	Mianzini TC	29	42.0	12.29	-0.82	0.415

Results from Tables 4.1 and 4.2 show that, the compared groups were statistically significantly different at $p \leq .05$. Although there was no statistical difference of sex as well as duty station on other variables, female and male respondents differed significantly on TUKD_G2 (male $_{mean}$ = 11.8; SD = 4.55, female $_{mean}$ =8.7, SD = 3.72, p = .016) and TUKD_G3 (male $_{mean}$ = 8.8, SD = 3.46; female $_{mean}$ = 6.8, SD=2.57, p = .043) on their mean scores. The effect size to compare the proportion of group differences were of medium effect for both TUKD_G2 (E^2 = .08 or 8%) and TUKD_G3 (E^2 = .06 or 6%). The effect size to ascertain the significance of variables was informed by Cohen's 1988 Eta squared test (Pallant, 2016). The first is .01 = "small effect", second, .06 = "medium effect", and the third, .14 "large effect". Having identified the pattern of differences in mean scores at knowledge deepening level, it was necessary to understand factors and evaluate their influence in predicting tutors' application of ICT-pedagogical competencies in teaching.

Factors Influencing Tutors' Application of ICT-Pedagogical Competencies in Teaching

This objective intended to evaluate how well the factors could predict tutors' application of ICT-pedagogical competencies in teaching. This evaluation would help researchers to make informed recommendations on the intervention needed to improve tutors' application of ICT-pedagogical competencies in teaching. To realise this outcome, the study used standard multiple regression model. Variables evaluated were the ICT-pedagogical competencies (dependent variable) which consisted of technologies used by tutors in the Knowledge Deepening level of ICT competencies (TUKD). Independent variables consisted of tutors' access and accessibility to ICT resources "Access"; ownership of laptops and smartphones "ownership"; actual use of ICT resources in teaching "Practice"; and attitude towards ICT use in teaching "Attitude". Standardised coefficients "Beta" values were used to ascertain the contribution of each factor in predicting the dependent variable with significance probability value ($p < .05$). Table 5 summarises the model's output.

As illustrated in Table 5, out of the four factors analysed in the model, only total practice made a unique significant prediction of the overall TUKD (Beta = .373, p = .019). This means, the overall model explained 21.6% of the variance in overall TUKD. The results suggest that, in every single unit of increase in practice, there will be an increase of .373 units of TUKD. This is a proportional relationship implying that the variables were positively correlated. However, the variables access (p = 0.47), ownership (p = 0.61) and attitude (p = 0.44) did not make a statistically significant unique contribution in predicting TUKD with ($p < .05$), probably due to overlapping with other independent variables in the model.

Table 5: Regression Coefficients for Dependent Variable Overall TUKD. Source: field data.

	Standardised Coefficients Beta	T	Sig.	Correlations		R^2	F	*p*-value	Collinearity Statistics	
				Partial	Part				Tolerance	VIF
Access	-0.084	-0.722	0.47	-0.089	-0.079	0.216	4.47	.003*	0.896	1.116
Ownership	0.071	0.507	0.61	0.063	0.056				0.61	1.64
Practice	0.373	2.399	.019*	0.285	0.263				0.499	2.006
Attitude	0.098	0.77	0.44	0.095	0.085				0.743	1.345

Checking for Assumptions

A key condition in regression analyses is ensuring that data meet the collinearity, normality, and outliers among other assumptions as interpreted in statistics (Field, 2017; Pallant, 2016; Tabachnick & Fidell, 2013). Multicollinearity manifests in extremely high or low correlations of independent variables. However, a cutoff point greater than (>.10) and Variance Inflation Factors (VIF) below 10 are acceptable in multiple regression tests (Tabachnick & Fidell, 2013). The statistics (Table 5) reveal that the independent variables did not violate the collinearity assumption as all variables had a tolerance indicator greater than .10 (Access = 0.896); (ownership = 0.61); (practice = 0.499) and (attitude = 0.7). Similarly, the variance Inflation Factor (VIF) statistics for all four independent variables (Table 5), were far below the cutoff point of 10 as recommended in statistics (Tabachnick & Fidell, 2013).

Normality assumption is illustrated using the distribution of residuals systematically from the center of the histogram or residuals forming a straight line along the probability plot (P-P) (Pallant, 2016). Figures 3 and 4 illustrate the normality assumption noted in this study.

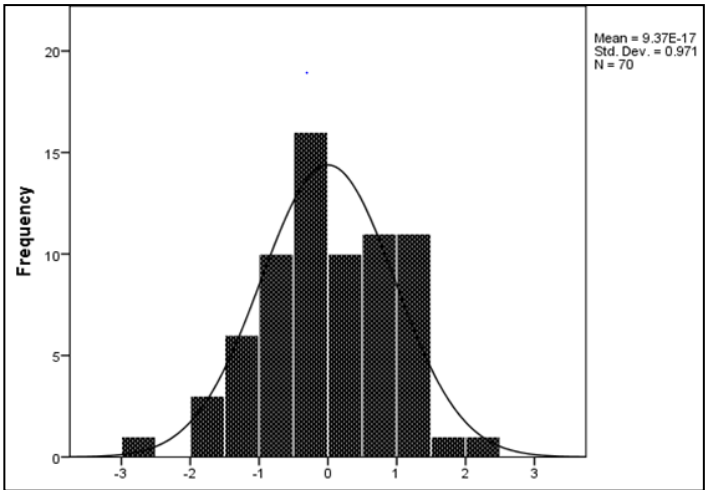

Figure 3: Regression standardised residual for overall TUKD

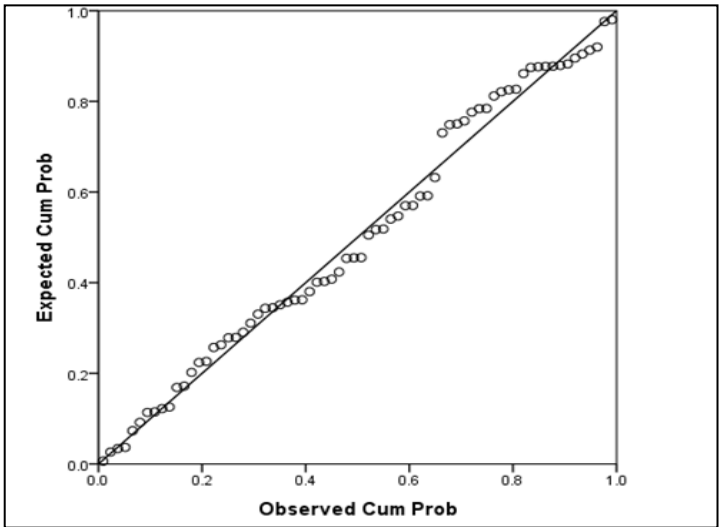

Figure 4: Normal P-P plot of the regression standardised residual for TUKD

Visual inspection of the regression standardised residual histogram (Fig. 3) shows data were reasonably symmetrical which means no serious deviation from normality. This is also supported by the P-P plot (Fig. 4) which show residuals reasonably distributed along the strait diagonal line from bottom left to top right revealing a positive linear relationship (Pallant, 2016).

Further, the model scatterplot output (Fig. 5) shows the distribution of residuals along the zero point in nearly rectangular shape. This distribution indicates that data had no serious outliers that could warrant data transformation or omission of variables as suggested in statistics (Tabachnick & Fidell, 2013).

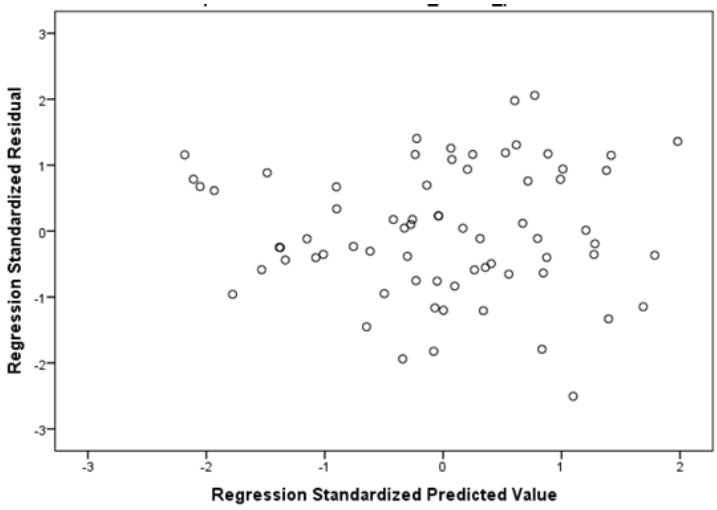

Figure 5: The scatterplot for overall TUKD

Findings from Qualitative Data

Like quantitative results, results from FGI showed that participants' level of ICT competencies was in basic ICT skills. This result is based on tutors' expressions when they answered a question that

inquired, "What ICT resources did you often use in teaching your lessons?" The response revealed that a large frequency of participants' views (7/10) used applications relevant to technological proficiency, as summarised in Table 6.

Table 6: Participants' Experiences in level of ICT Competencies

Participant	College Code	Description of Examples of ICT Use	Remarks
Chemistry	1	Use of internet to download models and electronic books	KA
ICT1	1	Browsing the internet to access content, use of C++ to teach simple programing in computer science class	KA
ICT2	1	Using notepad++ to teach web designing	KA
Curriculum and teaching	1	Using data projector to present my lessons through PowerPoint	KA
Biology	1	Use of YouTube videos to explain the lifecycle of Malaria parasites and fertilization in flowering plant	KD
Communication skills	1	Use of online dictionary and puzzles to teach phonetic articulation and new vocabularies	KD
Mathematics	2	Use of word processing to prepare lesson plan, lesson notes and scheme of work	KA
Biology 1	2	Use of PowerPoint to present lessons	KA
ICT/ICS	2	Use of spreadsheets to produce examination results and PowerPoint to present lessons in the class	KA
Biology 2	2	Use of Flash animations and PHET simulations to teach how digestion takes place	KD

Key: 1 = Mkasiwa, TC, 2 = Mianzini TC; KA = Knowledge Acquisition, KD = Knowledge Deepening

These findings (Table 6) suggest that basic ICT skills were more highly practiced than ICT-pedagogical competencies. However, tutors of ICT subjects applied complex applications like C++ and notepad ++ which signified proficiency in the same. Nevertheless, the complex applications were classified as technological competencies, because they were intended to develop technological skills like using programs and websites, respectively.

Tutors' use of applications like PHET simulations, Flash animations, videos and puzzles in the lessons (Table 6) suggests experiences in using ICT-pedagogical competencies in teaching. However, such experiences were few — only three (3), which suggests limited practice. To confirm this limitation, the study analysed tutors' lesson plans in order to see how ICTs were used in the lessons. Out of 49 lesson plans prepared from July 2020 to July 2021, only 11 mentioned the use of ICT. However, none of the 49 lessons mentioned or identified procedures for application of any ICT in the lesson development section. The findings not only revealed a gap in planning for ICT use in teaching but, also, could signify low competencies in actual use of ICT to achieve pedagogical value in a lesson.

In terms of factors, limited access and accessibility to ICT facilities and internet in colleges appeared as a constraint to ICT use in teaching, as described in the participants' views in excerpts A, B and C.

A. **Mathematics:** "We only have 23 computers fixed in ICT labs… We cannot easily use these computers to teach our subjects due to large class size up to 150 students… there are compulsory subjects like ICT and ICS with fixed timetable for all student teachers to use ICT labs in their learning…" (FGI Mianzini TC-February 19, 2020).

Similar views were expressed in excerpts B and C for Mkasiwa TC as follows:

> **B. ICT 2:** Currently we have 45 computers fixed in our ICT lab, 08 laptops and 16 projectors used for teaching… Over 560 student teachers (two years course) and 472 (Three years course) use the ICT labs in learning ICT and ICS compulsory subjects …" (FGI MkasiwaTC-March 17, 2020).
>
> **C. Biology:** "…Good news, about 98%of all 49 tutors use their own smartphones and laptops to search for teaching and learning materials… however, the college has no internet connection…we are obliged to use our own internet bundle to download teaching and learning materials…"(FGI MkasiwaTC-March 17, 2020).

While access and accessibility to ICT and internet for teaching and learning were crucial in tutors' practice, Excerpts A and B, showed that, the number of computers were few compared to the number of users — student teachers and tutors. Moreover, the ICT lab use arrangement seemed to be reserved for teaching ICT and Information and Computer Studies' (ICS) compulsory subjects. Although it was necessary to develop student teachers' basic ICT skills through ICT and ICS subjects, the concern was that there was no similar priority accorded to the use of ICT in teaching other subjects in teachers' colleges. It was even evident from the framework for the implementation of the Diploma in Teacher Education subjects, that ICT and ICS, like other subjects, are learnt because they are part of a curriculum requirement (TIE, 2019, 15). However, neither the curriculum nor the framework explicitly guides how ICT could be applied in teaching and learning across other subjects in teachers' colleges. The findings implied that the use of ICT in teaching and learning was not yet adequately streamlined in the curriculum implementation in teachers' colleges, and consequently, application of developed ICT-pedagogical competencies across subjects taught in teachers' colleges appeared like an optional undertaking.

Excerpt "C" show tutors' efforts to cope with internet access constraint. However, the use of their own laptops and smartphones remained at their discretion, as did the financial cost for an internet bundle. Despite the benefits of using tutors' own ICT facilities in teaching, innovation seemed to be left to tutors to continue or stop. This situation was due to limited supportive supervision to encourage tutors' innovative use of ICTs in their practice.

Discussion

Tutors' Level of ICT Competencies

While development of tutors' ICT-pedagogical competencies, intended to strengthen teacher preparation in Teachers' Colleges, findings of the current study (Table 3s), revealed limited tutors' practical know-how in planning and applying ICT-pedagogical competencies in teaching. While the basic ICT skills and ICT-pedagogical competencies were similarly developed in several competence development initiatives (Bernt et al., 2014; Binde et al., 2017; MoEVT, 2015), tutors' application of ICT-pedagogical competences reflected more theoretical understanding than practical experience. For instance, one could easily verify the use of basic ICT skills in tutors' work documents, like typed lesson plans and schemes of work, but teaching documents like lesson plans revealed limited evidence for ICT adoption in teaching. Similarly, if you compare results for basic ICT skills (Tables 2 and 6) with results for ICT-pedagogical competencies (Tables 3 and 6), you may notice that the competence development efforts played a key role in developing knowledge about ICTs, as well as knowledge of

how to use ICT competencies in teaching. However, it was not clear whether the training packages engaged tutors in hands-on practice in applying ICT teaching to basic ICT skills. Nevertheless, it was evident from the findings that the most proficiently practiced level of ICT competencies was basic ICT skills. But the most needed yet lowly practiced level of ICT competencies was ICT-pedagogical competencies (UNESCO, 2018).

Several studies confirm that, development of ICT-pedagogical competencies need to seamlessly bring together subject content and pedagogy with ICT-pedagogical competencies (Mishra & Koehler, 2006; UNESCO, 2018). Although it was possible to bring these domains together during ICT competence development, initiatives like the ICT project and TESP had separate sessions for teaching subjects, as well as ICT competencies (Bernt et al., 2014; Binde et al., 2017). With such disjointed complex domains, it seems the ICT competence development initiatives did not heed the complexity of integrating these domains as cautioned in several studies (Mishra & Koehler, 2006; Tondeur, 2018; UNESCO, 2018). Consequently, it is highly probable that inadequate balance between theoretical knowledge and hands-on-practice during competence development could be one of the causes for limited application of ICT-pedagogical competencies in Teachers' Colleges.

Factors Influencing Tutors' Application of ICT-Pedagogical Competencies

It was clear from the ETP, NICTP, ICT-CST and ICT competence development initiatives that tutors' ICT-pedagogical competencies are a crucial element in developing teachers who could use ICT in teaching at schools (Bernt et al., 2014; Binde et al., 2017; URT, 2014, 2015, 2016). However, what was developed in the training packages for tutors' ICT competencies mostly addressed ICT competencies (UNESCO, 2018). What seemed to constrain effective application of ICT-pedagogical competencies in teaching was tutors' inability to practically incorporate ICT competencies within the subject content and teaching and learning strategies. This result confirms the necessity for concurrent integration of subject content, pedagogical content knowledge and ICT-pedagogical competencies as strongly emphasised in TPACK (Koehler et al., 2013; Mishra & Koehler, 2006; Tondeur, 2018).

Moreover, the findings revealed a gap in management and administration of ICT use in teaching and learning. Despite tutors' ICT competence development for teaching, application of ICT-pedagogical competencies was constrained by lack of agreement at management and administration levels on whether or not ICT should be adopted in teaching and learning across all subjects taught in Teachers' Colleges. Educational and ICT policies and competence development initiatives in Tanzania imply ICTs need to be effectively employed in teaching and learning across all subjects in Teachers' Colleges (Bernt et al., 2014; URT, 2014, 2015, 2016). However, apart from the framework (TIE, 2019) and subjects' syllabi, which guide teaching of all subjects including ICT and ICS, there seemed to be no formal endorsement for the use of ICT in teaching all subjects in teachers' colleges.

The bottom line for the gap in management and administration is that ICT pedagogical competencies are developed in consistent progression, however, application in teaching is left at tutors' discretion. It is highly probable that tutors' high proficiency in basic ICT skills is because of the frequency of their application and positive pressure from management to encourage their application. On the contrary, ICT pedagogical competencies, which were expected to transform teaching and learning, appeared like an optional undertaking in Teachers' Colleges.

Conclusion

The reality on the ground is that, between basic ICT skills and ICT-pedagogical competencies developed for tutors, basic ICT skills were more proficiently practiced and frequently used by tutors. Application of basic ICT skills formed part of tutors' work culture. However, ICT-pedagogical competencies intended to innovate teaching and learning, were rarely practiced and their level of competence demonstrated by tutors was low. Despite the competence development efforts, two major factors influenced their effective application in teaching. First, the competence development process seemed to emphasise theoretical knowledge for ICT-competencies and how to employ them in teaching. The practical application in teaching seemed to be left to tutors to accomplish. Similarly, within Teachers' Colleges there seemed to be no strong emphasis and support to help tutors to consistently use their ICT competencies innovatively in teaching. Second, there seemed to be a gap in decision making at curriculum implementation and management levels on whether or not ICT should be integrated in teaching across all subjects. This gap caused emphasis in Teachers' Colleges to be in teaching ICT and ICS subjects because it was in the curriculum. It seemed the responsibility to use ICT in teaching was reserved for tutors of ICT/ICS. The remaining tutors did not effectively apply their ICT competencies in teaching. It appeared that it was no one's responsibility to enforce application of ICT pedagogical competencies in teaching. This means it was optional and at the tutors' discretion to apply. Consequently, it was highly probable that, the ICT competence development initiatives did not adequately improve preparation of teachers who could integrate ICT in teaching due to limited tutors' application of ICT-pedagogical competencies in teaching.

Recommendations

To policy and curriculum actors, the paper recommends realigning the policy rationales for ICT competence development and their integration in teaching across levels of policy implementation in order to overcome misinterpretation. To academicians and researchers, the study recommends an intervention study to bridge the gap between tutors' knowledge of the subject matter and knowledge of ICT in education competencies, the latter being referred to in this paper as ICT-pedagogical competencies.

References

Bernt, A., Ngemera, N., Edephonce, Suleman, S., Uimonen, P., & Pain, A. (2014). *Evaluation of Implementation of ICT in Teachers' Colleges Project in Tanzania* (No. 26). Sida. http://www.sida.se/publications

Binde, A. L., Sayi, L., & Kumburu, S. (2017). *TESP needs assessment in Teacher Colleges in Tanzania* (pp. 1-65) [Technical Report]. Centre for Management Excellence UK Limited. www.cmeuk.com

Cohen, L., Manion, L., & Morrison, K. (2018). *Research methods in education* (8th ed.). Routledge.

Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). SAGE Publications.

Ferrari, A. (2012). Digital competence in practice: An analysis of frameworks. *European Union, 2012*. https://doi.org/10.2791/82116

Ferrari, A., Brečko, B. N., & Punie, Y. (2014). DIGCOMP: A framework for developing and understanding digital competence in Europe. *In-Depth*, *38*. eLearning Papers. www.openeducationeuropa.eu/en/elearning_papers

Field, A. (2017). *Discovering statistics using IBM SPSS statistics* (5th ed.). SAGE Publications. https://www.pdfdrive.com/discovering-statistics-using-ibm-spss-statistics-d195143502.html

Fraillon, J., Ainley, J., Schulz, W., Duckworth, D., & Friedman, T. (2019). *IEA International Computer and Information Literacy Study 2018 Assessment Framework*. Springer International Publishing. https://doi.org/10.1007/978-3-030-19389-8

From, J. (2017). Pedagogical digital competence—Between values, knowledge and skills. *Higher Education Studies*, *7*(2), 43. https://doi.org/10.5539/hes.v7n2p43

Koehler, M. J., Punya, M., & Cain, W. (2013). What is Technological Pedagogical Content Knowledge (TPACK)? *Journal of Education*, *193*(3), 13-19. https://doi.org/10.1177/002205741319300303

Kozma, R. (2011). *The technological, economic, and social contexts for educational ICT policy. Transforming education: The power of ICT policies*. UNESCO.

Krumsvik, R. J. (2014). Teacher educators' digital competence. *Scandinavian Journal of Educational Research*, *58*(3), 269-280. https://doi.org/10.1080/00313831.2012.726273

Mishra, P., & Koehler, M. (2006). *Technological Pedagogical Content Knowledge: A framework for teacher knowledge*. *108*(6), 1017-1054. Teachers College Record, Columbia University.

MoEVT. (2015). *Evaluation report for the Teacher Development and Management Strategy (2008-2013)*. Ministry of Education and Vocational Training, Tanzania.

Ndibalema, P. (2014). *Teachers' attitudes towards the use of Information Communication Technology (ICT) as a pedagogical tool in secondary schools in Tanzania: The case of Kondoa District*, *2*(2), 16. http://ijern.com/journal/February-2014/11.pdf

Pallant, J. (2016). *SPSS survival manual: A step by step guide to data analysis using IBM SPSS* (6th ed.). McGraw Hill Education.

Pallant, J. (2020). *SPSS survival manual*. Open University Press. http://public.eblib.com/choice/PublicFullRecord.aspx?p=6215124

Tabachnick, B. G., & Fidell, L. S. (2013). *Using multivariate statistics* (6th international ed.). Pearson.

Tanzania Institute of Education. (2019). *The framework for implementation of a three year diploma in teacher education for science and business studies*. Tanzania Institute of Education. www.tie.go.tz

Tondeur, J. (2018). Enhancing future teachers' competencies for technology integration in education: Turning theory into practice. *Seminar.Net - International Journal of Media, Technology and Lifelong Learning*, *14*(2), 216-224. http://creativecommons.org/licenses/by/4.0/

Tondeur, J., Aesaert, K., Pynoo, B., van Braak, J., Fraeyman, N., & Erstad, O. (2017). Developing a validated instrument to measure preservice teachers' ICT competencies: Meeting the demands of the 21st century: ICT competencies for preservice teachers. *British Journal of Educational Technology*, *48*(2), 462-472. https://doi.org/10.1111/bjet.12380

UNESCO. (2015). *UNESCO ICT Competency framework for teachers*. UNESCO. http://unesdoc.unesco.org/images/0021/002134/213475e.pdf

UNESCO. (2017). *Leveraging Information and Communication Technology to achieve education 2030* (pp. 1–24). https://unesdoc.unesco.org/ark:/48223/pf0000259587?posInSet=1&queryId=N-EXPLORE-29d24e53-4c19-4469-b679-046cc0d1ee9f

UNESCO. (2018). *UNESCO ICT Competency Framework for Teachers: Version 3.* UNESCO.

United Republic of Tanzania. (2014). *Education and Training Policy*. Ministry of Education and Vocational Training, Tanzania. http://www.moe.go.tz/sw/publications/send/27-policy-sera/220-sera-ya-elimu-2014.html

United Republic of Tanzania. (2015). *ICT Competency standards for teachers in Tanzania*. Ministry of Education and Vocational Training. http://unesdoc.unesco.org/images/0023/002348/234822e.pdf

United Republic of Tanzania. (2016). *National Information and Communication Technology*. Tanzania Ministry of Works, Transport and Communication. https://tanzict.files.wordpress.com/2016/05/national-ict-policy-proofed-final-nic-review-2.pdf

United Republic of Tanzania. (2017). *National Framework for Continuous Professional Development*. https://tinyurl.com/yckvz4kc

van Wyk, M. M. (2018). Economics student teachers' views on the usefulness of a flipped classroom pedagogical approach for an open distance eLearning environment. *The International Journal of Information and Learning Technology*, *35*(4), 255-265. https://doi.org/10.1108/IJILT-07-2017-0068

Young, C. A. (2017). *Applying the flipped classroom model to English language arts education*. Information Science Reference.

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